

What is claimed is:

1. A method of wetting webs of paper or other hygroscopic material, comprising the steps of:
  - (a) forming a mixed gas stream that is the combination of a gas stream that has a swirling movement about a predetermined axis, one gas stream moving straight in the direction of said axis in the inner portion of the said swirling stream and another gas stream also moving straight in the direction of said axis said another gas stream wrapping around said swirling stream and said one straight gas stream;
  - (b) supplying a flow of liquid into said formed gas stream so that the flow of liquid is atomized by said formed gas stream; and
  - (c) advancing a web of hygroscopic material across the atomized liquid flow.
2. A method of wetting webs of paper or other hygroscopic material using an atomizing nozzle, comprising the steps of:
  - (a) forming in said nozzle a mixed gas stream that is the combination of a gas stream that has a swirling movement about a predetermined axis, one gas stream moving straight in the direction of said axis in the inner portion of the said swirling stream and another gas stream also moving straight in the direction of said axis said another gas stream wrapping around said swirling stream and said one straight gas stream;
  - (b) supplying a flow of liquid into said formed gas stream so that the flow of liquid is atomized by said formed gas stream; and
  - (c) advancing a web of hygroscopic material across the atomized liquid flow.
3. The method of Claim 2 wherein said supplying step

includes the step of inserting a liquid discharging tube into the path of said formed gas stream so that said formed gas stream surrounds said tube.

4. The method of Claim 2 wherein said atomizing nozzle is one nozzle in an array of said atomizing nozzles and said swirling gas stream in each of said atomizing nozzles in said array swirl in the same direction.
5. The method of Claim 2 wherein said atomizing nozzle is one nozzle in an array of said atomizing nozzles and said swirling gas stream in each of any two of said atomizing nozzles adjacent to each other in said array swirl in opposite directions.
6. A method of wetting webs of paper or other hygroscopic material, comprising the steps of:
  - (a) arranging at least first and second atomizing nozzles in an array wherein said at least first and second nozzles are adjacent to each other;
  - (b) forming in each of said at least first and second nozzles a mixed gas stream that is the combination of a gas stream that has a swirling movement about a predetermined axis, one gas stream moving straight in the direction of said axis in the inner portion of the said swirling stream and another gas stream also moving straight in the direction of said axis said another gas stream wrapping around said swirling stream and said one straight gas stream;
  - (c) supplying a flow of liquid into said formed gas stream so that the flow of liquid is atomized by said formed gas stream;
  - (d) advancing a web of hygroscopic material across the atomized liquid flow.
7. The method of Claim 6 wherein said first nozzle swirling stream and said second nozzle swirling

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stream swirl in the same direction.

8. The method of Claim 6 wherein said first nozzle swirling stream and said second nozzle swirling stream swirl in opposite directions.
9. A method of wetting webs of paper or other hygroscopic material using an atomizing nozzle, comprising the steps of:
  - (a) creating an array of said atomizing nozzles;
  - (b) forming in each of said nozzles a mixed gas stream that is the combination of a gas stream that has a swirling movement about a predetermined axis, one gas stream moving straight in the direction of said axis in the inner portion of the said swirling stream and another gas stream also moving straight in the direction of said axis said another gas stream wrapping around said swirling stream and said one straight gas stream;
  - (c) supplying a flow of liquid into said formed gas stream so that the flow of liquid is atomized by said formed gas stream; and
  - (d) advancing a web of hygroscopic material across the atomized liquid flow.
10. The method of Claim 9 wherein said swirling gas stream in each of said atomizing nozzles in said array swirl in the same direction.
11. The method of Claim 9 wherein said swirling gas stream in each of any two of said atomizing nozzles adjacent to each other in said array swirl in opposite directions.
12. Apparatus for atomizing a liquid with a gas comprising:
  - a) a housing having a gas discharging outlet and a liquid discharging outlet aligned flush with each other;
  - b) a first nozzle in said housing for producing at said gas discharging outlet and along a predetermined

axis a mixed gas stream that is the combination of a gas stream that has a swirling movement around said predetermined axis, a first gas stream moving straight in the direction of said axis in the inner portion of said swirling stream and a second gas stream also moving straight in the direction of said axis and wrapping around said swirling stream and said first gas stream;

- c) a second nozzle disposed in said first nozzle for producing at said liquid discharging outlet a controlled stream of liquid; and
- d) a gas stream divider disposed in said first nozzle and outside of said second nozzle, said gas stream divider maintaining the concentricity of said mixed gas stream and said controlled liquid stream.

13. The apparatus of Claim 12 further comprising a chamber for mixing said swirling stream, said first and said second straight streams to produce said mixed gas stream.

14. The apparatus of Claim 12 where said gas stream divider divides a gas stream entering said first nozzle into said swirling gas stream and said first and said second gas streams.

15. Apparatus for atomizing a liquid with a gas comprising:

- a) a first nozzle for producing in said apparatus and along a predetermined axis a mixed gas stream that is the combination of a gas stream that has a swirling movement around said predetermined axis, a first gas stream moving straight in the direction of said axis in the inner portion of said swirling stream and a second gas stream also moving straight in the direction of said axis and wrapping around said swirling stream and said first gas stream;
- b) a second nozzle disposed in said first nozzle for producing in said apparatus a controlled stream of liquid; and

c) a gas stream divider disposed in said first nozzle and outside of said second nozzle, said gas stream divider maintaining the concentricity of said mixed gas stream and said controlled liquid stream.

16. The apparatus of Claim 15 further comprising a chamber for mixing said swirling stream, said first and said second straight streams to produce said mixed gas stream.

17. The apparatus of Claim 15 where said gas stream divider divides a gas stream entering said first nozzle into said swirling gas stream and said first and said second gas streams.

18. The apparatus of Claim 15 further comprising a housing having a gas discharging outlet and a liquid discharging outlet aligned flush with each other, said mixed gas stream produced at said gas discharging outlet and said liquid stream produced at said liquid discharging outlet.

19. In a nozzle, a method for atomizing a liquid with a gas comprising the steps of:

(a) forming a mixed gas stream that is the combination of a gas stream that has a swirling movement about a predetermined axis, one gas stream moving straight in the direction of said axis in the inner portion of said swirling stream and another gas stream also moving straight in the direction of said axis said another gas stream wrapping around said swirling stream and said one straight gas stream; and

(b) supplying a flow of liquid into said formed gas stream so that the flow of liquid is atomized by said mixed gas stream.

20. The method of Claim 19 further comprising the step of emitting said liquid atomized by said formed gas stream from said nozzle.

21. The method of Claim 20 wherein said liquid

atomized by said formed gas stream is received by a web of hygroscopic material that advances across said emitted atomized liquid.

22. A method for atomizing a liquid with a gas comprising the steps of:
  - (a) forming a mixed gas stream that is the combination of a gas stream that has a swirling movement about a predetermined axis, one gas stream moving straight in the direction of said axis in the inner portion of said swirling stream and another gas stream also moving straight in the direction of said axis said another gas stream wrapping around said swirling stream and said one straight gas stream;
  - (b) atomizing a flow of liquid with said formed gas stream to produce fine droplets of said liquid; and
  - (c) adjusting at least one of said swirling gas stream, said one gas stream and said another gas stream in said mixed gas stream so that said droplets have a predetermined mass distribution profile.
23. In a nozzle for atomizing a liquid with a gas, said nozzle having an outlet, said nozzle comprising:
  - (a) a gas stream divider for dividing a gas stream entering said nozzle into a swirling gas stream that has a swirling movement about a predetermined axis, one gas stream moving straight in the direction of said axis in the inner portion of said swirling stream and another gas stream also moving straight in the direction of said axis; and
  - (b) a chamber for mixing said swirling stream, said one straight stream and said another straight stream to produce in said nozzle a mixed gas

stream that is the combination of said swirling stream, said one straight gas stream and said another straight gas stream, said another straight gas stream wrapping around said swirling stream and said one straight gas stream.

24. The nozzle of Claim 23 wherein said gas stream divider maintains the concentricity of a liquid stream in said nozzle and said mixed gas stream at said nozzle outlet.

25. An apparatus comprising:

an array of nozzles for atomizing a liquid with a gas, each of said nozzles having an outlet and each of said nozzles comprising:

(i) a gas stream divider for dividing a gas stream entering said nozzle into a gas stream that has a swirling movement about a predetermined axis, one gas stream moving straight in the direction of said axis in the inner portion of said swirling stream and another gas stream also moving straight in the direction of said axis; and

(ii) a chamber for mixing said swirling stream, said one straight stream and said another straight stream to produce in said nozzle a mixed gas stream that is the combination of said swirling stream, said one straight gas stream and said another straight gas stream, said another straight gas stream wrapping around said swirling stream and said one straight gas stream.

26. The apparatus of Claim 25 wherein said swirling gas stream in each of said nozzles in said array swirl in the same direction.

27. The apparatus of Claim 25 wherein said swirling gas stream in each of any two of said nozzles adjacent to each other in said array swirl in opposite directions.

28. The apparatus of Claim 25 wherein in each of said nozzles in said array said gas stream divider maintains the concentricity of a liquid stream in said

nozzle and said mixed gas stream at said nozzle outlet.

29. The apparatus of Claim 25 wherein said array of nozzles is used to wet a web of hygroscopic material.

30. The apparatus of Claim 25 wherein in each of said nozzles a flow of liquid is supplied into said mixed gas stream so that said liquid flow is atomized by said mixed gas stream.

31. The apparatus of Claim 30 wherein said atomized flow of liquid is emitted from each of said nozzles.

32. The apparatus of Claim 31 wherein said atomized flow of liquid emitted from each of said nozzles is received by a web of hygroscopic material that advances across said array of nozzles.

33. An apparatus comprising:

an array of nozzles for atomizing a liquid with a gas, each of said nozzles having an outlet and each of said nozzles comprising:

(i) a gas stream divider for dividing a gas stream entering said nozzle into a gas stream that has a swirling movement about a predetermined axis, one gas stream moving straight in the direction of said axis in the inner portion of said swirling stream and another gas stream also moving straight in the direction of said axis;

(ii) a chamber for mixing said swirling stream, said one straight stream and said another straight stream to produce in said nozzle a mixed gas stream that is the combination of said swirling stream, said one straight gas stream and said another straight gas stream, said another straight gas stream wrapping around said swirling stream and said one straight gas stream; and

(iii) a flow of liquid atomized by said mixed gas stream; and

a web of a hygroscopic material advancing across said array of nozzles.

34. The method of Claim 2 further comprising the step of adjusting at least one of said swirling gas

stream, said one gas stream and said another gas stream in said mixed gas stream so that said atomized liquid flow has a predetermined mass distribution profile.

35. The method of Claim 2 wherein said atomizing nozzle is one nozzle in an array of said atomizing nozzles and said method further comprises the step of adjusting in each of said atomizing nozzles in said array at least one of said swirling gas stream, said one gas stream and said another gas stream in said mixed gas stream so that said atomized liquid flow from each of said atomizing nozzles has a predetermined mass distribution profile.

36. The method of Claim 6 further comprising the step of adjusting in at least one of said first and second atomizing nozzles at least one of said swirling gas stream, said one gas stream and said another gas stream in said mixed gas stream so that said atomized liquid flow has a predetermined mass distribution profile.

37. The method of Claim 9 further comprising the step of adjusting in at least one of said atomizing nozzles in said array at least one of said swirling gas stream, said one gas stream and said another gas stream in said mixed gas stream so that said atomized liquid flow has a predetermined mass distribution profile.

38. The method of Claim 19 further comprising the step of adjusting at least one of said swirling gas stream, said one gas stream and said another gas stream in said mixed gas stream so that said atomized liquid flow has a predetermined mass distribution profile.